

Lamination Structure of Optical Module PCB



Overview

An optical PCB is built for systems where the circuit board interacts with light—not just electricity.

Key Takeaways

Optical module PCBs use a multilayer lamination structure combining high-speed dielectric materials, prepreg, copper cores, and embedded thermal elements to ensure signal integrity, thermal management, and mechanical precision. Core Lamination Layers

Optical module PCBs are typically multilayer boards where each layer serves a specific function. The lamination stackup generally includes:

- Core layers: Fully cured laminates with copper foil on one or both sides, providing mechanical stability and primary signal routing paths .
- Prepreg layers: Fiberglass cloth impregnated with partially cured epoxy resin (B-stage), which melts and flows during lamination to bond cores and fill gaps around copper features .
- Dielectric layers: High-speed materials such as Megtron 6/7 or Rogers are used instead of standard FR4 to support high-frequency signals (100G–800G) with controlled impedance .

Embedded Thermal Management

Due to the high heat density of TOSAs, ROSAs, and DSP chips, optical module PCBs integrate thermal dissipation structures directly into the lamination:

- Buried copper blocks: Embedded during lamination beneath heat-generating components. Inner layers often use circular or square blocks, while outer layers may use “T”-shaped blocks. Dense laser-drilled blind vias connect these blocks to conduct heat efficiently .
- Copper paste filling: An alternative to embedded blocks, offering lower cost and improved process reliability while maintaining thermal conductivity .
- Plated-through holes and ELIC structures: Stacked blind vias or columnar structures enhance heat conduction from the chip to the PCB surface .

Lamination Process Steps

The lamination process for optical module PCBs involves multiple stages to integrate electrical and thermal features:

- Layer cutting and inner layer circuitry formation
 - Buried drilling and electroplating
 - Resin hole filling and lamination under heat and pressure
 - Embedding copper blocks or filling vias with copper paste
 - Outer layer circuitry, solder resist, and surface finishing
 - Testing and final quality control During lamination, the prepreg resin flows around embedded copper blocks, bonding layers while maintaining precise dielectric thickness and mechanical flatness. Misalignment or prepreg residue can affect thermal performance and optical alignment, so strict process control is essential .
- #### Mechanical and Optical Considerations
- Dimensional stability: The PCB must maintain sub-micron flatness to align optical fibers and lenses accurately .
 - High-density interconnects (HDI): Stacked microvias and ultra-fine line/space features are used to route signals in compact form factors like QSFP-DD and OSFP .
 - Optical channels: Some designs etch channels in copper layers and fill them with optically clear material to guide light from TOSAs to ROSAs, fully integrated within the laminated structure .

Summary

The lamination structure of optical module PCBs is a carefully engineered multilayer stack combining high-speed dielectric cores, prepreg bonding layers, embedded copper blocks or paste for thermal management, and precise HDI routing. This structure ensures signal integrity at high data rates, effective heat dissipation, and mechanical precision necessary for optical transceivers in compact form factors .

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Optical module PCB production demands stringent quality control to ensure compliance at every stage, preventing manufacturing

Optical Module PCB Layout

The design of a small optical module PCB should be compatible with the limitations of the manufacture process, consisting of the

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